TSMC01-614

PLEASE AMEND THE CLAIMS

Claim 1 (currently amended) A method of forming a contact or via (contact/via), opening, in an insulator layer, comprising the steps of:

providing a conductive region;

forming a <u>conductive</u> stop layer on said conductive region;

depositing an insulator layer;

forming an initial contact/via opening in said insulator layer, exposing a portion of said <u>conductive</u> stop layer;

forming a fluorine based polymer layer at the bottom of said initial contact/via opening and upon said <u>conductive</u> stop layer; and

performing a procedure to in situ remove said fluorine based polymer layer, with fluorine based radical released from said fluorine based polymer layer during in situ removal procedure, resulting in etching of portions of said insulator layer exposed at bottom of said initial contact/via opening, creating a final contact/via opening.

Claim 2. (Original) The method of claim 1, wherein said conductive region is an active device region in a semiconductor substrate, such as a heavily doped source/drain region, or said conductive region is a metal structure.

Claim 3. (Currently amended) The method of claim 1, wherein said <u>conductive</u> stop layer is a titanium nitride layer, obtained via plasma vapor deposition procedures at a thickness between about 150 to 400 Angstroms.

Claim 4. (Original) The method of claim 1, wherein said insulator layer is a silicon oxide or a boro-phosphosilicate (BPSG), layer, obtained via LPCVD or PECVD procedures at a thickness between about 4000 to 15000 Angstroms.

Claim 5. (Original) The method of claim 1, wherein said initial contact/via opening is formed in said insulator layer via an reactive ion etching procedure, performed at a power between about 500 to 1000 watts, and at a pressure between about 30 to 200 mtorr, using CHF_3 as an etchant.

Claim 6. (Currently amended) The method of claim 1, wherein the etch rate ratio of said insulator layer to said conductive stop layer, in a CHF_3 ambient, is between about 5 to 1, to 20 to 1.

Claim 7. (Original) The method of claim 1, wherein said initial contact/via opening is comprised with a tapered profile shape, featuring a diameter at the top surface of said insulator layer between about 0.20 to 0.25 um, while the diameter located at the bottom of the opening is between about 0.15 to 0.18 um.

Claim 8. (Original) The method of claim 1, wherein said fluorine based polymer layer is obtained via a plasma deposition procedure, performed in situ in the same chamber used to define said initial contact/via opening, at a power between about 500 to 1000 watts, and at a pressure between about 30 to 200 mtorr, using a gas chosen from a group containing CH_2F_2, C_4F_4, C_4F_8/CO, and C_5F_8.

Claim 9. (Currently amended) The method of claim 1, wherein said fluorine based polymer layer is formed ~~at a thickness between about 0 to 500 Angstroms~~ to a thickness up to 500 Angstroms.

Claim 10. (Original) The method of claim 1, wherein an removal procedure for said fluorine base polymer layer is a plasma procedure, performed in situ in said chamber used for definition of said initial contact/via opening and for deposition of said fluorine based polymer layer, at a power between about 500 to 1000 watts, and at a pressure between about 30 to 200 mtorr, using an oxygen/argon ambient.

Claim 11. (Original) The method of claim 1, wherein said final contact/via opening is comprised with a diameter at the top of the opening between about 0.20 to 0.25 um, and with a diameter at the bottom of the opening between about 0.20 to 0.25 um.

Claim 12. (Currently amended) A method of forming a contact/via opening in an insulator layer, featuring a plasma polymer deposition and removal procedure used to modify said contact/via opening from a tapered profile shape to a vertical profile shape, comprising the steps of:

providing a conductive region;

forming a conductive stop layer on said conductive region;

depositing a silicon oxide layer;

performing a chemical mechanical polishing procedure to create a smooth top surface topography for said silicon oxide layer;

forming a photoresist shape on said silicon oxide layer, with an opening in said photoresist shape exposing a portion of a top surface of said silicon oxide layer;

performing a reactive ion etching (RIE) procedure to define an initial contact/via opening with a tapered profile shape, in said silicon oxide layer, and forming a thin polymer layer on said conductive stop layer located at bottom of said initial contact/via opening;

depositing an additional polymer layer via a plasma procedure performed in situ in same chamber used for definition of said contact/via opening, resulting in a thick polymer layer comprised of said thin polymer layer and of said additional polymer layer, with said thick polymer layer, located at the bottom of said initial contact/via opening, comprised of carbon and fluorine; and

removing said thick polymer layer, and said photoresist shape, via a plasma procedure performed in an oxygen containing ambient, in situ in same chamber used for deposition of additional polymer layer, with polymer removal procedure releasing fluorine based radicals which in turn etch of portions of said silicon oxide layer exposed at bottom of said initial contact/via opening, creating a final contact/via opening via, featuring a vertical profile shape.

Claim 13. (Original) The method of claim 12, wherein said conductive region is an active device region in a semiconductor substrate, such as a heavily doped source/drain region.

Claim 14. (Original) The method of claim 12, wherein said conductive region is a metal structure.

Claim 15. (Currently amended) The method of claim 12, wherein said conductive stop layer is a titanium nitride layer, obtained via plasma vapor deposition procedures at a thickness between about 150 to 400 Angstroms.

Claim 16. (Original) The method of claim 12, wherein said silicon oxide layer is obtained via LPCVD or PECVD procedures at a thickness between about 4000 to 15000 Angstroms.

Claim 17. (Original) The method of claim 12, wherein said RIE procedure, used to define said initial contact/via opening in said silicon oxide layer, is performed at a power between about 500 to 1000 watts, and at a pressure between about 30 to 200 mtorr, using CHF_3

as an etchant.

Claim 18. (Currently amended) The method of claim 12, wherein the etch rate ratio of said silicon oxide layer to said conductive stop layer, in a CHF_3 ambient, is between about 5 to 1, to 20 to1.

Claim 19. (Original) The method of claim 12, wherein said initial contact/via opening, formed with a tapered profile shape, is comprised with a diameter at the top of said initial contact/via opening between about 0.20 to 0.25 um, while the diameter located at the bottom of the opening is between about 0.15 to 0.18 um.

Claim 20. (Original) The method of claim 12, wherein said additional polymer layer is deposited via a plasma procedure performed in situ, in the same chamber used to define said initial contact/via opening, at a power between about 500 to 1000 watts, and at a pressure between about 30 to 200 mtorr, using a source gas chosen from a group containing CH_2F_2, C_4F_4, C_4F_8/CO, and C_5F_8.

Claim 21. (Currently amended) The method of claim 12, wherein said thick polymer layer, comprised of said thin polymer layer and of said additional polymer layer, is formed ~~at a thickness between about 0 to 500 Angstroms.~~ to a thickness up to 500 Angstroms.

Claim 22. (Original) The method of claim 12, wherein removal of said thick polymer layer is performed via a plasma procedure, in situ, in said chamber used for definition of said initial contact/via opening and for said deposition of said additional polymer layer, at a power between about 500 to 1000 watts, and at a pressure between about 30 to 200 mtorr, in an oxygen/argon ambient.

Claim 23. (Original) The method of claim 12, wherein said final contact/via opening, formed with said vertical shape profile, is comprised with a diameter at the top of the opening between about 0.20 to 0.25 um, and with a diameter at the bottom of the opening between about 0.20 to 0.25 um.

Claim 24. (Currently amended) A method of modifying an initial contact/via opening in an insulator layer, featuring a tapered profile shape, to a final contact/via opening, featuring a vertical profile shape, comprising the steps of:

forming a photoresist shape on said insulator layer, wherein said insulator overlays a conductive stop layer, with an opening in said photoresist shape exposing a portion of top surface of said insulator layer;

performing a plasma dry etch procedure with a first phase of said dry etch procedure used to form said initial contact/via opening comprised with said tapered profile shape in said insulator layer, and to form a thin polymer layer on said conductive stop layer located at bottom of said initial contact/via opening, then continuing with a second phase of said plasma dry etch procedure to form additional polymer at bottom of said initial contact/via opening; and

performing an in situ plasma oxygen procedure to remove said photoresist shape, to remove said thin polymer layer, and to remove said additional polymer layer, from said conductive stop layer located at bottom of said initial contact/via opening, with said in situ plasma oxygen procedure allowing release of fluorine based radicals from polymer layers, and with said fluorine based radicals etching portions of said insulator layer exposed at bottom of said initial contact/via opening, creating said final contact/via opening via, featuring said vertical profile shape.

Claim 25. (Original) The method of claim 24, wherein said initial contact/via opening, comprised with said tapered profile shape, has a top diameter opening between about 0.20 to 0.25 um, and a bottom diameter opening between about 0.15 to 0.18 um.

Claim 26. (Original) The method of claim 24, wherein said final contact/via opening, comprised with said vertical profile, has a top diameter opening between about 0.20 to 0.25 um, and a bottom diameter opening between about 0.20 to 0.25 um.